SIPROTEC 7SD60
Numerical Pilot-Wire Current Differential Protection Relay

The 7SD600 relay is a numerical current differential protection relay, simple to set, operating in conjunction with the remote station via a two pilot-wire link. It is connected to the primary current transformers via an external summation current transformer. The primary field of application of the relay is protection of short overhead lines and cables with two line ends. However, transformers and reactors may be located within the protection zone. Features like inrush restraint, lockout, modern PCM-intertrip facilities, full self-monitoring facilities, local and remote interrogation are integrated in the unit.

Function overview

Differential protection relay for overhead lines and cables
- Current differential protection with external summation current transformer 4AM49 (87L)
- Suitable for use for distances of approx. 12 km max. via two pilot wires (1200 Ω loop resistance)
- Differential protection can be combined with an overcurrent release
- Pilot-wire monitoring function
- Bidirectional remote tripping
- Circuit-breaker intertripping at the remote station
- Seal-in of the TRIP command until manual reset (Lockout function)
- Minimal current transformer requirements due to integrated saturation detector
- Restraint against inrush/undelayed trip for high differential fault currents
- Emergency overcurrent protection

Operational measured values
- Local and remote current
- Differential current
- Restraint current

Monitoring functions
- Hardware
- Firmware
- Spill current supervision

Hardware
- Local operation by means of integrated keyboard
- LCD display for settings and analysis
- Housing
  - Flush-mounting housing 1/6 19” 7XP20
  - Surface-mounting housing 1/6 19” 7XP20

Communication
- Via personal computer and DIGSI 3
- Via RS232→RS485 converter
- With modem
- With substation control system via IEC 60870-5-103 protocol
- 2 kV isolated RS485 interface, bus connection possible

Description

The 7SD600 relay is a numerical current differential protection relay, simple to set, operating in conjunction with the remote station via a two pilot-wire link. It is connected to the primary current transformers via an external summation current transformer. The primary field of application of the relay is protection of short overhead lines and cables with two line ends. However, transformers and reactors may be located within the protection zone. Features like inrush restraint, lockout, modern PCM-intertrip facilities, full self-monitoring facilities, local and remote interrogation are integrated in the unit.
The 7SD60 relay is a numerical current differential protection relay, simple to set, and is operated in conjunction with the remote station via a two pilot-wire link.

It is connected to the primary current transformers via an external summation current transformer. The unit operates internally on the summated current taken from the secondary side of the summation current transformer. The link to the remote station is realized by means of a pair of symmetrical pilot wires allowing distances of up to approximately 12 km. Adaptation to the pilot-wire resistance is effected by means of software within the unit. Therefore, matching is not necessary.

The primary field of application of the unit is protection of short overhead lines and cables with two line ends. However, transformers and reactors may be located within the protection zone. The unit can be fitted with inrush restraint in such cases. A differential protection instantaneous tripping stage is also provided in this case. Vector group adaptation is not effected inside the unit and must, if necessary, be effected by means of a matching current transformer.

The 7SD60 can be fitted with a pilot-wire monitoring function. In addition to monitoring the pilot-wire link to the remote station, this also includes bidirectional circuit-breaker intertripping and a remote tripping command.

If the differential protection becomes inactive due to a pilot-wire failure, the relay has an emergency overcurrent function as an option. It includes one definite-time overcurrent stage and can be delayed.

This unit substitutes the 7SD24 steady-state differential protection. However, direct interoperation with the 7SD24 is not possible. On replacement of a 7SD24, its external summation current transformer can be used as the input transformer for the 7SD60.

---

**ANSI**

- 87L, 87T ΔI for lines/cables, transformers
- 83 Intertrip, remote trip
- 86 Lockout function
- 50 Single-stage, definite-time emergency overcurrent protection

**Construction**

The compact 7SD60 protection relay contains all the components for:

- Measured-value acquisition and evaluation
- Operation and LCD indications
- Alarm and command contacts
- Input and evaluation of binary signals
- Data transmission via the RS485 bus interface to DIGSI or a substation control system
- Auxiliary voltage supply

The primary current transformers are connected to the 4AM49 summation current transformer. At the rated current value of either 1 A or 5 A, the latter outputs a current of 20 mA which is measured by the 7SD60 unit. The summation current transformer is supplied together with the protection unit, if so ordered.

The unit can be supplied in two different housings. The one for flush mounting in a panel or cubicle has connection terminals at the rear. The version for panel surface mounting is supplied with terminals accessible from the front. Alternatively, the unit can be supplied with two-tier terminals arranged above and below the unit.
Mode of operation of the differential protection relay

An external summation current transformer 4AM49, which can be supplied as an accessory either in a 1 A or a 5 A version, allows any secondary currents of the primary current transformers (see Fig. 7/3) to be connected. The standard ratios of the three primary windings of the summation current transformer are \(IL1:IL2:IL3 = 5:3:4\) (\(IL1:IL3:IL0 = 2:1:3\)) (see Fig. 7/6). In consequence, the sensitivity of the tripping characteristic for single-phase faults is appreciably higher compared to that for two-phase and three-phase faults. Since the current on such faults is often weak, an amplification factor of 1.7 to 2.8 referred to the symmetrical response value is achieved.

Other sensitivity values can, however, be obtained by altering the connections at the summation CT.

With a symmetrical three-phase current of \(1 \times I_N\), the secondary current of the summation current transformer is 20 mA.

The 7SD60 measures and digitalizes the current \(I_{B1}\) of the local relay by means of a sensitive current input (see Fig. 7/6). A voltage drop occurs across a fixed-value resistor \(R_b\) installed in the unit. With a through-flowing load or a through-flowing short-circuit current, the voltage drop at both ends of the line is approximately equal but of opposite polarity, so that no current flows through the pilot wire. On occurrence of an internal fault, different values are obtained for the voltage drop across \(R_b\) at both ends. In consequence, a current \(I_a\) flows through the pilot wire, which is measured by means of the current transformer. In conjunction with the pilot-wire resistance (available as a parameter in the unit) and the internal resistor \(R_a\), it is possible to calculate the differential current from the measured current flowing through the pilot wire. As soon as an adjustable value is reached, the protection relay trips the line at both ends.

Matching of the sensitivity of the unit for different values of pilot-wire resistance is effected by the firmware of the unit during parameter setting, so that time-consuming matching of the pilot-wire resistance is unnecessary.

Trip characteristic of the differential protection relay

The main function of the unit is current comparison protection. The trip characteristic is fixed and takes into account both the linear and the non-linear errors of the current transformers. It is only necessary to set the tripping value \(I_{Diff}\), although the standard setting is suitable for most applications. It should be parameterized according to the rated current of the line; sensitive setting is possible even when the current transformer rated currents and the line rated currents differ by as much as a factor of 2.

Differences in the current transformation ratios at the ends of the line must, however, be compensated for by means of external matching current transformers.

In some cases, this can be realized by the summation current transformer.
Protection functions

Overcurrent release / differential current monitoring

The differential protection function can be combined with an additional overcurrent release. To this end, the criteria “overcurrent” and “differential current” are linked logically so that a TRIP command is given out by the differential function only when a differential current and an overcurrent coexist.

By this means it is often possible to avoid malfunctioning due to pilot-wire short-circuit or wire-break of a connection between a current transformer and the summation current transformer. For this purpose, the 7SD60 is fitted with an additional differential current monitoring function, which can effectively block the differential protection after a delay of some seconds on reaching of an adjustable value of differential current in conjunction with simultaneous operational current $I_{hi}$ within the load range.

Saturation detector

Improved stability on single-ended saturation of the primary current transformers is ensured by means of an integrated saturation detector. It provides additional stability during external faults. 5 ms are enough time to measure an external fault due to a high restraint and small differential current. Indication is done within the additional restraint area (see Fig. 7/4). If – due to CT saturation – the differential current flows into the trip area, the differential trip is blocked for a certain time. Transient saturation of current transformers caused by decaying DC components in the short-circuit current can thus be recognized.

As a result, the requirements on the current transformers are reduced so that they are only required to conduct the steady-state through-flowing short-circuit current without saturation.

Pilot-wire link / pilot-wire monitoring

The link to the remote station comprises a symmetrical pair of wires (e.g. telephone lines). The maximum permissible distance between two stations is approximately 12 km. 7XR9513 (20 kV) or 7XR9515 (5 kV) isolation transformers can be employed for potential isolation against interference induced by longitudinal voltages where the pilot wires run parallel to power cables over long distances.

Since the pilot wires form an integral part of the differential protection, these are normally monitored continuously. This function is available as an option. To achieve this, 2 kHz pulses with a defined pulse width ratio are transmitted to the remote relay via the pilot wires. Detection of a fault in the pilot-wire link results in blocking of the differential protection.

Emergency overcurrent protection

If the differential protection becomes inactive due to a pilot-wire failure or an internal or external blocking of the differential function, the relay offers a single-stage, definite-time overcurrent function. It works with the local flowing operational current $I_{hi}$. The pickup value and the delay time are settable via parameters in the device.

Circuit-breaker intertripping / remote tripping

Normally, tripping is effected at both stations as a result of current comparison. Tripping at one end only can occur when an overcurrent release is used or with short-circuit currents only slightly above the tripping value. Circuit-breaker intertripping can be parameterized in the unit with integral pilot-wire monitor, so that definite tripping at both ends of the line is assured.

In addition, it is possible by means of a binary input to output a remote tripping command for both directions. The command transmission time is approximately 80 ms.

Lockout of the TRIP command with manual reset

The TRIP command can be locked-out after tripping. In particular, in the case of transformers within the protection zone, reclosure of the line is normally effected only after the cause of the fault has been ascertained by the user. Manual reset is possible either via the operator panel (with password) or via a binary input. As a result, premature reclosure of the circuit-breaker is prevented. The logic state of the TRIP command remains stored even during failure of the auxiliary supply voltage, so that it is still present on restoration of the auxiliary supply voltage.

Inrush restraint / instantaneous tripping stage

Where transformers or reactors are located within the protection zone, inrush restraint can be supplied as an option. This inrush restraint evaluates the second harmonic of the differential current, which is typical for inrush phenomena. If the second harmonic value of the differential current referred to the fundamental frequency exceeds a preset value, tripping by the differential protection is blocked. In the case of high-current internal faults, whose amplitude exceeds the inrush current peak, tripping can be carried out instantaneously.

Vector group adaptation is not effected inside the unit and must, where necessary, be brought about by means of an external matching transformer scheme.
Serial data transmission

As standard, the unit is fitted with an RS485 interface. This is suitable for connection to a bus and allows up to 32 devices to be connected via a two-wire serial interface (use of a third core for earth is recommended). A PC is connected via this interface using an RS232↔RS485 converter, thus allowing the DIGSI operator program to be used, by means of which PC-aided planning, parameter setting and evaluation can be performed. By this read-out, it is also possible to output the fault recordings stored by the unit on occurrence of faults.

Using an RS485↔820 nm optical converter as an accessory (7XV5650, 7XV5651), it is possible to provide an interference-free and isolated link to a central control system or a remote control system employing DIGSI, thus allowing economically viable configurations to be used, e.g. for remote diagnostics.

The serial interface can also be set to the IEC 60870-5-103 protocol (VDEW - Association of German Utilities - interface), thus allowing the unit to be integrated in a substation control system. However, only 2 messages (ready for operation and the trip signal) and the fault recording are available.

For this reason, it is recommended to use the 7SD610 unit combined with an external communication converter for pilot wires in those cases in which integration in the substation control system is a prime consideration.

Fig. 7/5
Bus communication via RS485 interface
For convenient wiring of RS485 bus, use bus cable system 7XV5103
(see part 15 of this catalog).
Connection diagrams

Fig. 7/6
Standard connection L1-L3-E, suitable for all types of networks

CAUTION!
The pilot wires may neither be earthed nor fitted with surge arresters.

Fig. 7/7
Protection configuration with main (7SD60) and backup overcurrent (7SJ60) protection

Fig. 7/8
Typical circuit for auxiliary voltage supply
## Technical data

### General unit data

#### Input circuits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current $I_N$</td>
<td>20 mA without summation current transformer 1 or 5 A with summation current transformer</td>
</tr>
<tr>
<td>Rated frequency $f_N$</td>
<td>50/60 Hz parameterizable</td>
</tr>
</tbody>
</table>

#### Auxiliary voltage

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary voltage via integrated DC/DC converter</td>
<td>24/48 V DC / 60/110/125 V DC / 19 to 58 V DC /48 to 150 V DC /176 to 300 V DC</td>
</tr>
<tr>
<td>Superimposed AC voltage $V_{aux}$ Peak-to-peak</td>
<td>$\leq 12%$ at rated voltage / $\leq 6%$ at limits of admissible voltage</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Quiescent Approx. 2 W / Energized Approx. 4 W</td>
</tr>
<tr>
<td>Bridging time during failure/ short-circuit of auxiliary voltage</td>
<td>$\geq 50$ ms (at $V_{aux} \geq 100$ V AC/DC) / $\geq 20$ ms (at $V_{aux} \geq 24$ V DC)</td>
</tr>
<tr>
<td>Rated auxiliary voltage AC $V_{aux}$ permissible variations</td>
<td>115 V AC / 88 to 133 V AC</td>
</tr>
</tbody>
</table>

### Command contacts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of relays</td>
<td>2 (marshallable)</td>
</tr>
<tr>
<td>Contacts per relay</td>
<td>2 NO or 1 NO</td>
</tr>
<tr>
<td>Switching capacity</td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td>1000 W/VA</td>
</tr>
<tr>
<td>Break</td>
<td>30 W/VA</td>
</tr>
<tr>
<td>Switching voltage</td>
<td>250 V</td>
</tr>
<tr>
<td>Permissible current</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>5 A</td>
</tr>
<tr>
<td>For 0.5 s</td>
<td>30 A</td>
</tr>
</tbody>
</table>

### Signal contacts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of relays</td>
<td>3 (2 marshallable)</td>
</tr>
<tr>
<td>Contacts per relay</td>
<td>1 CO</td>
</tr>
<tr>
<td>Switching capacity</td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td>1000 W/VA</td>
</tr>
<tr>
<td>Break</td>
<td>30 W/VA</td>
</tr>
<tr>
<td>Switching voltage</td>
<td>250 V AC/DC</td>
</tr>
<tr>
<td>Permissible current</td>
<td>5 A</td>
</tr>
</tbody>
</table>

### Binary inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>3 (marshallable)</td>
</tr>
<tr>
<td>Operating voltage</td>
<td>24 to 250 V DC</td>
</tr>
<tr>
<td>Current consumption, energized</td>
<td>Approx. 2.5 mA independent of operating voltage</td>
</tr>
<tr>
<td>Pick-up threshold reconnectable</td>
<td>By solder bridges</td>
</tr>
<tr>
<td>Rated aux. voltages 24/48/60 V DC</td>
<td>$V_{pick-up} \geq 17$ V DC / $V_{drop-off} &lt; 8$ V DC</td>
</tr>
<tr>
<td>Rated aux. voltages 110/125/220/250 V DC</td>
<td>$V_{pick-up} \geq 74$ V DC / $V_{drop-off} &lt; 45$ V DC</td>
</tr>
</tbody>
</table>

### Unit design

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>7XP20</td>
</tr>
<tr>
<td>Dimensions</td>
<td>For dimensions, see dimension drawings, part 17</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 4.5 kg</td>
</tr>
<tr>
<td>With housing for surface mounting</td>
<td>Approx. 4 kg</td>
</tr>
<tr>
<td>With housing for flush mounting/cubicle mounting</td>
<td>Approx. 4 kg</td>
</tr>
<tr>
<td>Degree of protection acc. to EN 60529</td>
<td>IP 51</td>
</tr>
<tr>
<td>Terminals</td>
<td>IP 21</td>
</tr>
</tbody>
</table>

### Serial interface (Isolated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>RS485</td>
</tr>
<tr>
<td>Test voltage</td>
<td>2.8 kV DC for 1 min</td>
</tr>
<tr>
<td>Connection</td>
<td>Via wire to housing terminals, 2 data transmission lines, 1 earthing cable for connection to an RS485+›RS232 converter, cables have to be shielded, screen has to be earthed Setting at supply: 9600 baud</td>
</tr>
<tr>
<td>Baud rate</td>
<td>Min. 1200 baud; max. 19200 baud</td>
</tr>
</tbody>
</table>
### Technical data

#### Electrical tests

**Specification**

<table>
<thead>
<tr>
<th>Standards</th>
<th>IEC 60255-5 ANSI/IEEE C37.90.0</th>
</tr>
</thead>
</table>

**Insulation tests**

<table>
<thead>
<tr>
<th>Voltage test (routine test)</th>
<th>2 kV (r.m.s.), 50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>All circuits except DC voltage supply and RS485</td>
<td>2.8 kV DC</td>
</tr>
<tr>
<td>Only DC voltage supply and RS485</td>
<td></td>
</tr>
<tr>
<td>Impulse voltage test (type test)</td>
<td>5 kV (peak), 1.2/50 μs, 0.5 J; 3 positive and 3 negative impulses at intervals of 5 s</td>
</tr>
<tr>
<td>All circuits, class III</td>
<td></td>
</tr>
</tbody>
</table>

**Test crosswise:**

- Measurement circuits, pilot wire connections, power supply, binary inputs, class III,
- (no tests crosswise over open contacts, RS485 interface terminals)

#### EMC tests for noise immunity; type tests

**Standards**

- IEC 60255-5-6; IEC 60255-22 (international product standard)
- EN 50082-2 (generic standard)
- VDE 0435, Part 303 (German product standard)

<table>
<thead>
<tr>
<th>High-frequency test</th>
<th>2.5 kV (peak); 1 MHz; τ = 15 μs; 400 surges; duration 2 s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge</td>
<td>4.6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R/L = 330 Ω</td>
</tr>
<tr>
<td>Irradiation with RF field, non-modulated IEC 60255-22-3 class III</td>
<td>10 V/m 27 to 500 MHz</td>
</tr>
<tr>
<td>Irradiation with RF field, amplitude-modulated IEC 61000-4-3; ENV 50204; class III</td>
<td>10 V/m 80 to 1000 MHz; AM 80 %; 1 kHz</td>
</tr>
<tr>
<td>Irradiation with RF field, pulse-modulated IEC 61000-4-3; ENV 50204; class III</td>
<td>10 V/m, 900 MHz; repetition rate 200 Hz, duty cycle 50 %</td>
</tr>
</tbody>
</table>

**Fast transients/bursts**

- IEC 60255-5-6; IEC 60255-22 (international product standard)
- EN 50082-2 (generic standard)
- VDE 0435, Part 303 (German product standard)

<table>
<thead>
<tr>
<th>Fast transients/bursts</th>
<th>2 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities; R/L = 50 Ω; duration 1 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-conducted RF amplitude-modulated IEC 61000-4-3; ENV 50204; class III</td>
<td>10 V; 150 kHz to 80 MHz; AM 80 %; 1 kHz</td>
</tr>
<tr>
<td>Power frequency magnetic field IEC 61000-4-8; class IV; EN 60335-6</td>
<td>30 A/m; 50 Hz, continuous 300 A/m for 3 s; 50 Hz; 0.5 μT, 50 Hz</td>
</tr>
<tr>
<td>Oscillatory surge withstand capability ANSI/IEEE C37.90.1 (common mode)</td>
<td>2.5 to 3 kV (peak), 1 MHz to 1.5 MHz decaying oscillation; 50 shots per s; duration 2 s; R/L = 150 Ω to 200 Ω</td>
</tr>
<tr>
<td>Fast transient surge withstand capability ANSI/IEEE C37.90.1 (common mode)</td>
<td>4 to 5 kV; 10/150 ns; 50 shots per s; both polarities; duration 2 s; R/L = 80 Ω</td>
</tr>
<tr>
<td>Radiated electromagnetic interference ANSI/IEEE C37.90.2</td>
<td>10 to 20 V/m; 25 to 1000 MHz; amplitude and pulse-modulated</td>
</tr>
</tbody>
</table>

#### EMC tests for interference emission; type tests

**High-frequency test**

- Document 17C (SEC) 102
- 2.5 kV (peak, alternating polarity) 100 kHz, 1 MHz, 10 and 50 MHz, decaying oscillation; R/L = 50 Ω

**Mechanical dynamic tests**

#### Vibration, shock stress and seismic vibration

**During operation**

**Standards**

- IEC 60255-5-6; IEC 60255-22 (international product standard)
- EN 50082-2 (generic standard)
- VDE 0435, Part 303 (German product standard)

<table>
<thead>
<tr>
<th>Vibration</th>
<th>10 to 60 Hz; ± 0.035 mm amplitude; sweep rate 1 octave/min; 20 cycles in 3 orthogonal axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock</td>
<td>Half-sine 5 g acceleration, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes</td>
</tr>
</tbody>
</table>

**Seismic vibration**

- IEC 60255-5-6; IEC 60255-22 (international product standard)
- EN 50082-2 (generic standard)

<table>
<thead>
<tr>
<th>8 to 150 Hz; ± 0.035 mm amplitude; sweep rate 1 octave/min; 20 cycles in 3 orthogonal axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half-sine 5 g acceleration, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes</td>
</tr>
</tbody>
</table>

**During transport**

**Standards**

- IEC 60255-5-6; IEC 60255-22 (international product standard)
- EN 50082-2 (generic standard)
- VDE 0435, Part 303 (German product standard)

<table>
<thead>
<tr>
<th>Vibration</th>
<th>5 Hz to 8 Hz; ± 7.5 mm amplitude 8 Hz to 150 Hz; 2 g acceleration 50 shots in 1 octave/min; 20 cycles in 3 orthogonal axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock</td>
<td>Half-sine Acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes</td>
</tr>
<tr>
<td>Continuous shock</td>
<td>Half-sine Acceleration 5 g, duration 16 ms, 1000 shocks in each direction of 3 orthogonal axes</td>
</tr>
</tbody>
</table>
**Technical data**

### Climatic stress test

**Temperatures**

**Standards**

EN 60255-6, IEC 60255-6
DIN VDE 0435 Part 303

**Recommended temperature**

-5 to +55 °C (>55 °C/131 °F decreased display contrast)

**Limit temperature**

-20 to +70 °C - 4 to +158 °F
-25 to +55 °C -13 to +131 °F
-25 to +70 °C -13 to +158 °F

**Humidity**

It is recommended to arrange the units in such a way that they are not exposed to direct sunlight or pronounced temperature changes that could cause condensation.

**Mean value per year ≤ 75 % relative humidity, on 30 days a year up to 95 % relative humidity, condensation not permissible!**

### Functions

**Line differential protection**

**Note**

All current values refer to the symmetrical current using standard connection.

**Setting ranges**

- Current threshold $I_1$ (release by local station current)
- Differential current
- Delay time $t$

**Restrainment by 2nd harmonic**

(see Fig. 7/4)

$2I_0 / I_N$

**Reset ratio**

10 to 80 % Approx. 0.7 – drop-off ratio ($k_{aux} = 0$)

**Inherent delays**

- TRIP time for two-end supply at 4 x set value
- Drop-off time

**Tolerances at preset values under reference conditions**

- Local station current threshold
- Differential current

**Influence parameters**

- Auxiliary supply voltage $0.8 \leq V_{aux} \leq 1.15$
- Temperature in range
- Temperature $°C \leq \Theta_{amb} \leq 40 °C$
- Frequency in range $0.9 \leq f / f_N \leq 1.1$

**Pilot wires**

- Number

<table>
<thead>
<tr>
<th>Core-to-core asymmetry at 800 Hz</th>
<th>Maximum loop resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1.2 kW, however, max. 60 % of the test voltage of the pilot wires</td>
<td>Permissible induced longitudinal voltages</td>
</tr>
<tr>
<td>≤ 2</td>
<td>On direct connection of the pilot wires</td>
</tr>
<tr>
<td>≤ 2</td>
<td>For connection via isolating transformer</td>
</tr>
</tbody>
</table>

**Additional functions**

**Pilot-wire monitoring and intertripping (optional)**

- Monitoring signal
- Alarm signal delay 1 to 60 s (step 1 s)
- Inherent delay time of intertripping Approx. 65 ms
- Extension of the intertripping signal 0 to 5 s (step 0.01 s)

**Emergency overcurrent protection**

**Setting ranges**

| Overcurrent pickup value $I_{aux} / I_{auxmax}$ |
| Delay time |
| 0.1 to 15 (step 0.1) | 0.0 to 60 s (step 0.01 s) |

**Remote trip**

**Note**

Tripping of the remote end circuit-breaker for units with pilot-wire monitoring only.

**Setting ranges**

- Prolongation time for transmission to remote station 0 to 60 s (step 0.01 s)
- Delay time for reception from the remote station 0 to 60 s (step 0.01 s)
- Prolongation time for reception from the remote station 0 to 60 s (step 0.01 s)

**Tolerances**

- Delay time/release delay 1 % and 10 ms respectively
- Inherent delay

**Transmission time without delay**

Approx. 80 ms

**Lockout function**

**Lockout seal-in of trip command**

For differential protection and remote trip until reset

**Lockout reset**

By means of binary input and/or local operator panel/DIGSI

### Additional functions

**Operational measured values**

**Operational currents**

$I_1, I_2, I_{diff}, I_{instant}$

**Measurement range**

0 to 240 % $I_N$

**Tolerance ($I_1$)**

5 % of rated value or of measured value

**Fault event recording**

Storage of the events relating to the last 8 faults

**Time-tagging**

Resolution for operational events for fault events

1 s
1 ms

**Fault recording (max. 8 faults)**

**Storage time (from response or trip command)**

Total of 5 s max., pre-trigger and post-fault time settable

**Maximum length per recording $T_{max}$**

0.30 to 5.00 s (step 0.01 s)

**Pre-trigger time $T_{pre}$**

0.05 to 0.50 s (step 0.01 s)

**Post-fault time $T_{post}$**

1 instantaneous value per 1.66 ms
1 instantaneous value per 1.38 ms

**Circuit-breaker test**

Using test circuit
### Technical data

#### 4AM4930 summation current transformer

Power consumption in the circuit with standard connection L1-L3-E (Fig. 7/6) referred to the through-flowing rated current (7SD600 unit in operation).

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Single-phase</th>
<th>Symmetrical three-phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>2.2</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td>0.35</td>
</tr>
<tr>
<td>5 A</td>
<td>3.5</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

#### Connections

- 4AM4930-7DB: $I_N = 1$ A
- 4AM4930-6DB: $I_N = 5$ A

#### Number of turns

<table>
<thead>
<tr>
<th>Primary windings</th>
<th>A to B</th>
<th>C to D</th>
<th>E to F</th>
<th>G to H</th>
<th>I to K</th>
<th>K to L</th>
<th>L to M</th>
<th>Y to Z</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>1736</td>
</tr>
<tr>
<td>Secondary windings</td>
<td>Y to Z</td>
<td>1736</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Thermal rating

- Continuous current in Amperes
  - A to B: 4.5
  - C to D: 4.5
  - E to F: 4.5
  - G to H: 4.5
  - I to K: 1.2
  - K to L: 1.2
  - L to M: 1.2
  - Y to Z: 0.2

#### Secondary rated current with standard connection (see Fig. 7/6) and symmetrical 3-phase current

| Y to Z | 20 mA |

#### Requirements for the current transformers (CT)

\[
\frac{I_{\text{acc max}}}{I_p} \leq 4 \quad \text{and:} \quad \frac{3}{4} \left( K_{\text{ssc1}} \cdot I_p \right)_{\text{acc max}} \leq 4 \left( K_{\text{ssc2}} \cdot I_p \right)_{\text{acc max}}
\]

- $K_{\text{ssc1}}$ = effective symmetrical short-circuit current factor end 1
- $K_{\text{ssc2}}$ = effective symmetrical short-circuit current factor end 2
- $I_{\text{acc max}}$ = maximum symmetrical short-circuit current
- $I_p$ = CT rated primary current

### CE conformity


This unit conforms to the international standard IEC 60255, and the German standard DIN 57435/Part 303 (corresponding to VDE 0435/Part 303).

Further applicable standards: ANSI/IEEE C37.90.0 and C37.90.1.

This conformity is the result of a test that was performed by Siemens AG in accordance with Article 10 of the Council Directive complying with the generic standards EN 50081-2 and EN 50082-2 for the EMC Directive and standard EN 60255-6 for the "low-voltage Directive".
## Selection and ordering data

<table>
<thead>
<tr>
<th>Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7SD60 numerical pilot-wire current comparison protection relay</strong></td>
<td>7SD600/□□A□0-□DA0</td>
</tr>
</tbody>
</table>

### Rated current; rated frequency
- 20 mA, 50/60 Hz; without external summation current transformer (0)
- 1 A, 50/60 Hz; with external summation CT 4AM4930-7DB00-0AN2 (1)
- 5 A, 50/60 Hz; with external summation CT 4AM4930-6DB00-0AN2 (5)

### Rated auxiliary voltage
- 24, 48 V DC (2)
- 60, 110, 125 V DC (4)
- 220, 230 V DC, 115 V AC, 50/60 Hz (5)

### Unit design
- For panel surface mounting with terminals at the side (B)
- with terminals on top and bottom (D)
- For panel flush mounting or cubicle mounting (E)

### Operating language
- English – alternatively either German or Spanish can be selected (0)

### Scope of functions
- Differential protection (0)
- Differential protection, inrush restraint (1)
- Differential protection, pilot-wire monitoring, remote trip (2)
- Differential protection, pilot-wire monitoring, remote trip, inrush restraint (3)

### Accessories

#### DIGSI 4
Software for configuration and operation of Siemens protection units running under MS Windows (Windows 2000 or XP Professional) device templates, Comtrade Viewer, electronic manual included as well as "Getting started" manual on paper, connecting cables (copper)

- **Basis**
  - Full version with license for 10 computers, on CD-ROM (authorization by serial number) 7XS5400-0AA00

- **Professional**
  - DIGSI 4 Basis and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation) 7XS5400-0AA00

#### SIGRA 4
(generally contained in DIGSI Professional, but can be ordered additionally)
Software for graphic visualization, analysis and evaluation of fault records. Can also be used for fault records of devices of other manufacturers (Comtrade format). Running under MS Windows (Windows 2000 and XP Professional).

- Incl. templates, electronic manual with license for 10 PCs. Authorization by serial number. On CD-ROM. 7XS5410-0AA00

#### Connecting cable
Cable between PC/notebook (9-pin connector) and protection unit (9-pin connector) (contained in DIGSI 4, but can be ordered additionally) 7XV5100-4
### Accessories

<table>
<thead>
<tr>
<th>Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Converter R232 (V.24) - RS485</strong></td>
<td></td>
</tr>
<tr>
<td>With connecting cable 1 m, PC adapter,</td>
<td>7XV5700-0[111][111]</td>
</tr>
<tr>
<td>with plug-in power supply unit 230 V AC</td>
<td>7XV5700-1[111][111]</td>
</tr>
<tr>
<td>With plug-in power supply unit 110 V AC</td>
<td></td>
</tr>
<tr>
<td><strong>Converter RS485-FO</strong></td>
<td></td>
</tr>
<tr>
<td>Rated auxiliary voltage 24 to 250 V DC and 250 V AC</td>
<td></td>
</tr>
<tr>
<td>Single optical interface</td>
<td>7XV5650-0BA00</td>
</tr>
<tr>
<td>Double optical interface (cascadable)</td>
<td>7XV5651-0BA00</td>
</tr>
<tr>
<td><strong>Summation current transformer</strong></td>
<td></td>
</tr>
<tr>
<td>1 A, 50/60 Hz, for 7SD60</td>
<td>4AM4930-7DB00-0AN2</td>
</tr>
<tr>
<td>5 A, 50/60 Hz, for 7SD60</td>
<td>4AM4930-6DB00-0AN2</td>
</tr>
<tr>
<td><strong>Isolating transformer</strong></td>
<td></td>
</tr>
<tr>
<td>Up to 20 kV</td>
<td>7XR9513</td>
</tr>
<tr>
<td>Up to 5 kV</td>
<td>7XR9515</td>
</tr>
<tr>
<td><strong>Manual for 7SD60</strong></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>E50417-G1176-C069-A3</td>
</tr>
</tbody>
</table>

1) Possible versions see part 15.
- RS485 bus system up to 115 kbaud
- RS485 bus cable and adaptor
  7XV5103-0[111][111]; see part 15.
Connection diagram of the 7SD60 current differential protection
Dimension drawings in mm / inch

Dimension drawings for 1/6 x 19" housing (7XP20)

Fig. 17/15
Housing for panel flush mounting / cubicle mounting, terminals at rear (1/6 x 19")

Fig. 17/16
Housing for surface mounting, terminals at top and bottom (1/6 x 19")
Dimension drawings in mm / inch

Dimension drawings for 1/6 x 19" housing (7XP20)

Front view

Side view

Fig. 17/17
Housing for panel surface mounting, terminals on the side (1/6 x 19")